HP 346A
346B, 346C

OPERATING AND SERVICE MANUAL

346A
346B
346C

NOISE SOURCE

(Including Options 001, 002, and 004)

346A NOISE SOURCE 10 MHz-18 GHz
HEWLETT · PACKARD
MADE IN U.S.A.
CAUTION: TO CONNECT OR DISCONNECT NOISE SOURCE, ROTATE CONNECTOR NUT ONLY. DO NOT ROTATE NOISE SOURCE BODY.
28 V DC INPUT
MAX REV PWR 1W
346B NOISE SOURCE 10 MHz-18 GHz
346C NOISE SOURCE 10 MHz-26.5 GHz

HEWLETT
PACKARD

HP 346A
346B, 346C

HEWLETT PACKARD

CALIBRATION REPORT

MODEL: 346A OPT 001 SERIAL NO: 2614A01072
DATE: OCTOBER 09 1987 TECHNICIAN: 222175

FREQUENCY	ENR	REFL - ON		REFL - OFF		REFL
MHz	dB	MAG	ANG	MAG	ANG	CHANGE
10	5.27	.007	-157.4	.003	-125.8	.005
100	5.41	.006	158.9	.001	137.7	.005
1000	5.20	.010	34.8	.005	47.4	.005
2000	5.04	.012	-84.1	.012	-63.3	.004
3000	4.96	.008	-170.6	.012	-162.0	.004
4000	4.92	.012	147.0	.012	128.8	.004
5000	4.90	.019	62.6	.016	62.8	.004
6000	4.98	.021	-10.0	.022	-.7	.004
7000	5.00	.013	-81.8	.016	-82.4	.003
8000	5.03	.008	148.4	.011	137.9	.003
9000	5.25	.017	63.9	.016	53.8	.003
10000	5.28	.026	-10.1	.023	-7.0	.003
11000	5.31	.022	-88.7	.023	-81.8	.003
12000	5.30	.019	166.7	.022	168.2	.003
13000	5.26	.023	51.5	.025	47.8	.003
14000	5.21	.038	-27.6	.037	-31.2	.003
15000	5.24	.044	-109.7	.042	-108.4	.003
16000	5.24	.037	165.4	.037	168.9	.002
17000	5.27	.033	56.8	.035	58.4	.002
18000	5.19	.053	-44.9	.055	-46.3	.002

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: HP 346A/B/C
Date Printed: NOV. 1983
Part Number: 00346-90010

NOISE SOURCE

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes

► NEW ITEM

ERRATA

Title Page, under Serial Numbers:

► Change serial number prefixes for 346A to 2336A and 2614A.

► Change serial number prefixes for 346B to 2401A and 2614A.

Change serial number prefix for the 346C to 2339A.

Page 2, Table 3:

Add the following under 346A.

4. Not directly useable for HP 8970A IF attenuator calibration (Special Function 33). 10 dB of gain is required.

Add the following under 346B and 346C:

4. Suitable for HP 8970A IF attenuator calibration (Special Function 33).

Page 3, Equipment Available But Not Supplied:

Delete the entry for the 11711A Noise Source Adapter.

Delete the paragraph below the equipment list.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

31 March 1986
1 Page

HEWLETT
PACKARD

Printed in U.S.A.

OPERATING AND SERVICE MANUAL

346A
346B
346C
NOISE SOURCE

(Including Options 001, 002, and 004)

SERIAL NUMBERS

This manual applies directly to instruments having the following serial number prefixes:
346A-2336A
346B-2401A
346C-3339A
With changes described in the MANUAL CHANGES appendix, this manual also applies to 346B Noise Sources prefixed 2330A and lower.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL.

HEWLETT
PACKARD

© Copyright HEWLETT-PACKARD COMPANY 1979, 1983
1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

MANUAL PART NUMBER. 00346-90010
Microfiche Part No. 00346-90011

Printed: NOVEMBER 1983

Digitized by the Internet Archive
in 2024 with funding from
Amateur Radio Digital Communications, Grant 151

https://archive.org/details/operatingservice00unse_9

GENERAL INFORMATION

This manual contains operating and service information for the Hewlett-Packard Model 346A, 346B, and 346C Noise Sources. Included in the manual is information necessary to operate the Noise Sources. On the title page of this manual below the manual part number is a "microfiche" part number. This number may be used to order a 10 x 15 cm (4 x 6 inch) microfilm transparency of the manual.

Specifications

Instrument specifications are listed in Table 1. These specifications are the performance standards, or limits against which the instrument can be tested. Supplemental characteristics in Table 2 are not specifications but are typical characteristics included as additional information for the user.

Instruments Covered By Manual

The Noise Sources covered by this manual have a two part serial number. The first four digits and letter constitute the serial number prefix. The last five digits form a sequential suffix that is unique to each Noise Source. The prefix is the same for all Noise Sources of a particular configuration. It will

Table 1. Specifications

ENR accuracy: calibrations at cardinal frequencies are printed on each noise source and on a separate report shipped with each 346 Noise Source to the accuracy shown in the following table.

Frequency (GHz)	Worst Case Uncertainty (dB)	Root-Sum-of-Squares Uncertainty (dB)
0.01 to 7	0.30	0.09
8 to 10	0.27	0.09
11 to 12	0.28	0.09
13 to 18	0.30	0.11
19 to 20	0.40	0.15
21	0.50	0.19
22 to 23	0.58	0.21
24 to 26.5	0.67	0.30

Frequency range: 10 MHz to 18 GHz for 346A and 346B; 10 MHz to 26.5 GHz for 346C.

Excess noise ratio (ENR) range: calibrated values at cardinal frequencies printed on label. Range of value is 4.5 through 6.5 dB for 346A, 14 to 16 dB for 346B, and 12 to 16 dB (10 MHz to 12 GHz) and 14 to 17 dB (12 to 26.5 GHz) for 346C.

Maximum SWR (reflection coefficient) for source ON and source OFF (50 ohm reference impedance):
346A/B: 10 to 30 MHz — 1.3 (0.13)
30 to 5000 MHz — 1.15 (0.07)
5 to 18 GHz — 1.25 (0.11).
346C: 10 MHz to 18 GHz — 1.25 (0.11)
18 to 26.5 GHz — 1.35 (0.15).

Maximum change in complex reflection coefficient between source ON and source OFF at all frequencies for 346A only: 0.01.

Power required: 28 ± 1V.
346A/B: 60 mA peak, 30 mA average for source ON.
346C: 45 mA.

Operating temperature: 0 to 55° C.

Connectors: bias: BNC(f); noise output: APC-3.5(m)—also mates with female SMA connectors. See option information for other connector styles.

Maximum reverse power: 1W.

Dimensions: 140 x 21 x 31 mm (5.5 x 0.8 x 1.2 in.).

Net Weight: 0.1 kg (3.5 oz).

Table 2. Supplemental Characteristics

ENR variation with temperature: <0.01 dB/°C for 30 MHz to 26.5 GHz.

ENR variation with voltage: internal current regulator for <0.02 dB variation for 28 ±1V.

Switching speed: for repetitive operation (in previous state for less than 5 seconds), turn-on: <20 μs; turn-off: <80 μs. For single shot operation (in previous state more than 5 seconds), turn-on: <3 ms; turn-off: <80 μs.

Instruments Covered By Manual (cont'd)

change when a design modification occurs. The contents of this manual apply directly to those instruments having the same serial number prefixes listed under SERIAL NUMBERS on the title page.

A Noise Source manufactured after the printing of this manual may have a serial number prefix which is higher than the prefixes listed on the title page. This indicates that the Noise Source is different than those documented in this manual. The manual for these instruments is supplied with a yellow manual changes supplement that contains change information to document the differences. To keep this manual as current and accurate as possible, Hewlett-Packard suggests that you periodically request the latest copy of the MANUAL CHANGES supplement. Identify the supplement with the manual print date and part number, both of which appear on the title page. Complimentary copies of this supplement are available from Hewlett-Packard.

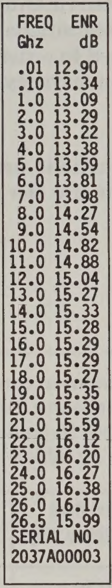
Model 346B Noise Sources which were manufactured before the printing of this manual will have a serial number prefix lower than the one listed on the title page. Manual changes for these older models are found in the appendix entitled MANUAL CHANGES at the back of this manual.

Description

The Noise Source produces noise output (power-on) when +28 V is applied. When it is off, there is residual noise due to thermal agitation in the Noise Source (power-off). These two noise levels are used to measure the gain and added noise of the device under test, and consequently, its noise figure.

The Excess Noise Ratio (ENR) for each Noise Source has been measured at major frequencies and recorded on a label attached to the Noise Source (see Figure 1). ENR references power-on to the noise power that exists at 290 Kelvins (17°C). In addition, a separate calibration sheet showing the complex reflection coefficient in both the on and off states is included with each instrument.

All 3 models are provided with a BNC female connector for power input. The output connector is a male APC-3.5 on the standard Noise Sources. Type-N and APC-7® connectors are available as options for the 346A and 346B Noise Sources. In addition to these general characteristics, certain characteristics apply to the specific models. These characteristics are listed in Table 3.



FREQ Ghz	ENR dB
.01	12.90
.10	13.34
1.0	13.09
2.0	13.29
3.0	13.22
4.0	13.38
5.0	13.59
6.0	13.81
7.0	13.98
8.0	14.27
9.0	14.54
10.0	14.82
11.0	14.88
12.0	15.04
13.0	15.27
14.0	15.33
15.0	15.28
16.0	15.29
17.0	15.29
18.0	15.27
19.0	15.35
20.0	15.39
21.0	15.59
22.0	16.12
23.0	16.20
24.0	16.27
25.0	16.38
26.0	16.17
26.5	15.99

SERIAL NO.
2037A00003

Figure 1. Typical Calibration Label

Table 3. Individual Noise Source Model Characteristics

346A	1. Reflection coefficient differential between on and off states is specified to be no greater than 0.01. 2. Specified output noise spectrum from 10 MHz to 18 GHz. 3. Nominal ENR is 6 dB over the specified frequency range.
346B	1. Reflection coefficient differential between on and off states is not specified, but is less than 0.1 typically. 2. Specified output noise spectrum from 10 MHz to 18 GHz. 3. Nominal ENR is 15 dB over the specified frequency range.
346C	1. Reflection coefficient differential between on and off states is not specified, but is less than 0.1 typically. 2. Specified output noise spectrum from 10 MHz to 26.5 GHz. 3. Nominal ENR is 15 dB over the specified frequency range.

®A registered trademark of the Bunker Ramo Corporation.

Warranty

The Noise Sources are warranted and certified as indicated on the inside of the rear cover of this manual. Connector damage resulting from improper use is not covered under warranty.

Equipment Available But Not Supplied

The following equipment is available from Hewlett-Packard for use with the Noise Sources:

11711A	Noise Source Adapter
5060-0343	3/4" Torque Wrench (APC-7)
5060-0344	9/16" Torque Wrench (APC-3.5)

The 11711A Adapter is used with the Hewlett-Packard Model 340B and 342A Noise Figure Meters to drive the 346A and 346B Noise Sources. The adapter does not provide enough current to drive the 346C Noise Source. Refer to the Operating and Service Manuals for the 340B, 342A, and 11711A for further information.

Options

The 346A and 346B Noise Sources are available with the following output connector options:

Option 001, Type-N (male)
Option 002, APC-7
Option 004, Type-N (female)

Since the APC-7 and Type-N connectors do not operate up to 26.5 GHz, no output connector options are available for the 346C.

Recommended Test Equipment

Table 4 is a list of equipment that can be used to perform an operational verification check.

INSTALLATION

Handling Precautions

CAUTION

Do not disassemble the Noise Source. The diode module is static sensitive and can be damaged or the calibration can be altered.

CAUTION

Do not drop the Noise Source. Dropping can damage unit or alter the calibration.

Table 4. Recommended Test Equipment For Operator's Checks

Check No.	Instrument	Critical Specification	Recommended Model
1	Power Meter and Power Sensor	Minimum Sensitivity 0.1 nW Frequency range: 10 MHz to 18 GHz	HP 436A with HP 8484A
	Power Supply	Voltage: 28.0 ±1.0V Current: 100 mA	HP 6218A
2	Noise Figure Meter	Voltage Output 28.0 ±1.0V Input Noise Figure: <7.4 FdB @ 100 MHz	HP 8970A

Proper connector care is essential. See OPERATOR'S MAINTENANCE in the OPERATION section of this manual for more information.

Initial Inspection

Inspect the shipping container for damage. Inspect the Noise Source for mechanical damage incurred in transit. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the Noise Source has been mechanically and electrically checked. If the contents are incomplete, if there is mechanical damage or a defect, or if the Noise Source does not work electrically, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of unusual stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

Original Packaging

Container and materials identical to those used in factory packaging are available through Hewlett-

Original Packaging (cont'd)

Packard offices. If the Noise Source is being returned to Hewlett-Packard for servicing, attach a tag indicating the name and address of the company, the technical contact person, phone number and extension, the model number, serial number, type of service being requested, and failure symptoms if applicable. For this purpose, blue service tags have been provided at the back of this manual. Mark the shipping container FRAGILE. In any correspondence, refer to the Noise Sources by model number and serial number.

Mating Connectors

The Noise Sources can be mated with other instrumentation having the connectors listed in Table 5.

Table 5. Connectors That Can Be Mated With the Noise Sources

Configuration	Mating Connector
Input: all units	BNC male*
Output: standard	APC-3.5 female SMA female
Opt. 001	Type-N female*
Opt. 002	APC-7
Opt. 004	Type-N male*

*Must comply with U.S. Military Standard MIL-C-39012.

Storage and Shipping Environment

The Noise Sources should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature: −55°C to +75°C
Humidity: <95% relative
Altitude: <15 300 metres (50 000 feet)

OPERATION

This section refers to operation with noise figure meters. For more detailed operating instructions, refer to the operating manual for the noise figure meter used.

CAUTION

Use a dc blocking capacitor to protect the Noise Source from damage when connected to any system where a dc voltage is present on the output center conductor.

Noise figure measurements of devices (such as amplifiers, mixers, transistors, and receivers) can be made using the Noise Source with a noise figure meter. Figure 2 depicts a simple test setup for a noise figure measurement. Note that the noise figure meter must have a +28 ± 1V switched supply.

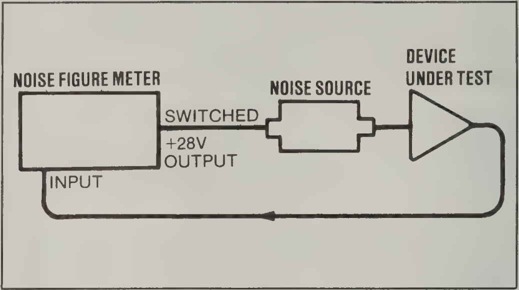


Figure 2. Typical Noise Figure Measurement Test Setup

Operating Environment

The operating environment of the Noise Sources should be within the following limitations:

Temperature: 0°C to +55°C
Humidity: <95% relative
Altitude: <4600 metres (15 000 feet)

Operator's Checks

The operator's checks in this section should be performed if failure of the Noise Source is suspected. The checks can be used only to verify that the Noise Sources are producing a broadband noise spectrum. They can not be used to check the units against specifications. Only one of the checks is necessary to verify operation. Table 4 shows the recommended test equipment used for each check.

Operator's Check with Power Meter (Check No. 1). Connect the equipment as shown in Figure 3 and follow this procedure:

1. Turn power supply off and zero set the power meter.

2. Turn power supply on (+28V) and measure the power output with the Noise Source on.

3. If the result of the measurement is within the following limits, the Noise Source is operating correctly:

   a. 346A Power output= −66 ± 4 dBm
   b. 346B Power output= −56 ± 4 dBm
   c. 346C Power output= −56 ± 4 dBm.

Operator's Checks (cont'd)

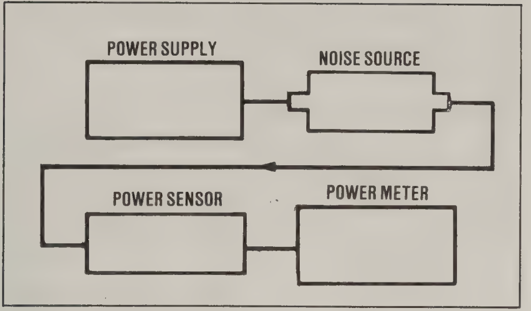


Figure 3. Operator's Check Test Setup 1

Operator's Check With HP Model 8970A Noise Figure Meter (Check No. 2)

1. Remove any cables from the noise figure meter input. Press PRESET. Verify Noise Figure display shows, "--FdB" and left display shows "30 MHz" after 5 seconds.

2. Connect the equipment as shown in Figure 4.

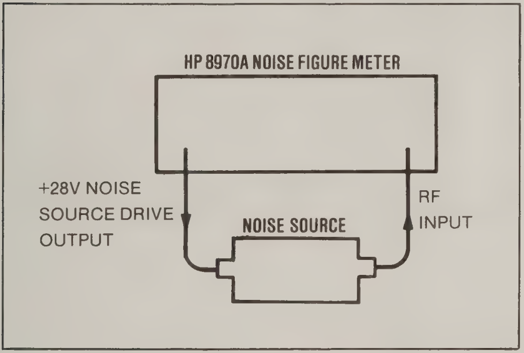


Figure 4. Operator's Check Test Setup 2

3. Enter a tuned frequency of 100 MHz. (See FIXED FREQUENCY TUNING in the 8970A Operating and Service Manual).

4. Enter special function 5.3 to enable the instrument for spot ENR entry. (See SPECIAL FUNCTIONS in the 8970A Operating and Service Manual).

5. Enter the ENR at 100 MHz from the Noise Source calibration label. (See SPOT ENR, T_{hot}, AND T_{cold} in the 8970A Operating and Service Manual).

6. The noise figure measurement of the noise figure meter will appear in the Noise Figure display. If the result of the measurement is less than 7.4 FdB, the Noise Source is operating.

7. Press PRESET to return the instrument to preset conditions.

Operator's Maintenance

Proper connector care is a vital part of the maintenance which should be performed by the user. By following the general connector care practices outlined below, the life of the connector can be greatly extended.

1. Connectors should be properly torqued as shown in Table 6.

Table 6. Connector Torque Specifications

Connector Type	Torque Specifications
N	10 in · lb (1.1 N · m)
APC-7	12 in · lb (1.3 N · m)
SMA to APC-3.5	8 in ·lb (0.9 N · m)
APC-3.5 to APC-3.5	8 in · lb (0.9 N · m)

2. Always tighten or loosen a connector by rotating only the nut. Never rotate the Noise Source body.

3. Use isopropyl or ethyl alcohol on a swab to clean connectors. Absorbent, lint-free paper wrapped around the end of tweezers is recommended. Carefully clean the conductive surfaces and dielectric. After cleaning, be sure connector is blown dry before re-assembly.

4. It is good practice to inspect a connector after cleaning. During the inspection, check for contaminants and worn plating. Also check for a misaligned center conductor or spread fingers on the APC-3.5 or Type-N connectors.

5. Support the cable or component attached to the connector.

6. When using APC-7 connectors, the nut of one connector should always be backed off completely and the nut on the mating connector should be tightened. Never set an APC-7 connector on its mating surface. Before storage, always screw the nut out to protect the surfaces.

Operator's Maintenance (cont'd)

7. Be sure connectors are axially aligned before the nut is tightened.

8. Use a connector gauge periodically to check the center pin depth. The shoulder of the center conductor must never extend beyond the plane of the outer conductor mating surface in an APC-3.5 connector.

For a more complete description of connector care, refer to application note 326-1 entitled "Connector Care and Maintenance". A copy of this note may be obtained through the nearest Hewlett-Packard office.

PERFORMANCE TESTS

Due to the complex test equipment involved, there are no recommended performance tests for the user to perform. Return the Noise Sources to Hewlett-Packard when tests are required to verify its performance and for periodic re-calibration. The suggested interval before initial re-calibration is one year.

ADJUSTMENTS

There are no adjustments that can be made on the Noise Sources by the user.

REPLACEABLE PARTS

If any parts need replacement, return the instrument to Hewlett-Packard.

SERVICE

Troubleshooting

Check the connectors. If there is no apparent damage to the connectors, perform one of the operator's checks described in the OPERATION section of this Manual. If the Noise Source's output does not fall within the stated range, or if the connectors are damaged, return the unit to Hewlett-Packard for repair.

Repair

Repair by the user is not recommended because of the complex equipment required for test and calibration.

APPENDIX
MANUAL CHANGES

INTRODUCTION

This section contains information for adapting this manual to Model 346B Noise Sources that have a serial number prefix which is 2330A and lower.

MANUAL CHANGES

To adapt this manual to your instrument, refer to Table 7 and make all of the manual changes listed opposite your instrument's serial number prefix. Perform these changes in the sequence listed.

If your instrument (all models) has a serial number prefix which is higher in value than those listed on the title page of this manual, it may be documented in a yellow MANUAL CHANGES supplement. For additional information, refer to INSTRUMENTS COVERED BY MANUAL in the GENERAL INFORMATION section of this manual.

Table 7. Manual Changes by Serial Number

Serial Number Prefix	Make Manual Changes
1935A, 2015A	C, B, A
2037A	C, B
2330A	C

CHANGE A

Table 2. Supplemental Characteristics:

Change Switching Speed for both repetitive operation and single shot operation to read: Turn off <140 μs.

CHANGE B

Table 1. Specifications:

Change "Worst Case Uncertainty" and "Root Sum of Squares Uncertainty" for cardinal frequencies from 10 MHz through 18 GHz to read as follows:

Frequency (MHz)	Worst Case Uncertainty (dB)	Root Sum of Squares Uncertainty (dB)
10	0.34	0.10
100	0.34	0.10
1000	0.34	0.10
2000	0.34	0.10
3000	0.34	0.10
4000	0.34	0.10
5000	0.35	0.10
6000	0.35	0.10
7000	0.37	0.10
8000	0.37	0.10
9000	0.38	0.13
10000	0.39	0.13
11000	0.39	0.14
12000	0.40	0.14
13000	0.50	0.18
14000	0.51	0.18
15000	0.52	0.18
16000	0.54	0.18
17000	0.55	0.18
18000	0.57	0.19

CHANGE C

Figure 1. Typical Calibration Label:

Replace Figure 1 with Figure A-1.

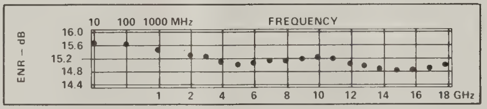


Figure A-1. Typical Calibration Label

Page 2, 2nd Paragraph under Description:

Change 1st sentence to read, "The Excess Noise Ratio (ENR) for each Noise Source has been measured at major frequencies and plotted on a label. . ."

Page 3, under Equipment Available But Not Supplied:
Delete, “5060-0344 . . . . . . 9/16” Torque Wrench (APC-3.5)”.

NOTE

Model 346B Noise Sources manufactured before the printing of this manual have an APC-3.5 connector of a different configuration (see Figure A-2). The 9/16” torque wrench will not fit these older connectors.

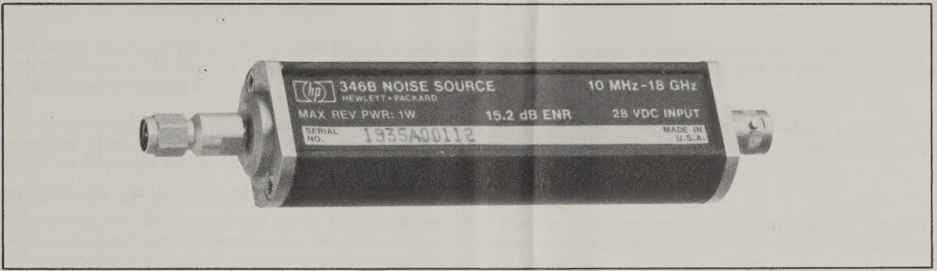


Figure A-2. HP Model 346B Noise Source with Older Configuration APC-3.5 Connector

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

HEWLETT-PACKARD SERVICE OFFICES

To obtain servicing information, contact the nearest Hewlett-Packard Sales and Service Office in HP Catalog, or contact the nearest regional office listed below.

UNITED STATES

NO. CALIFORNIA (San Francisco Area)
333 Logue Ave.
Mt. View, CA 94043

SO. CALIFORNIA (Los Angeles Area)
Instrument Repair Center
1421 S. Manhattan Ave.
Fullerton, CA 92631

GEORGIA
450 Interstate N. Parkway
Atlanta, GA 30348

ILLINOIS
5201 Tollview Dr.
Rolling Meadows, IL 60008

NEW JERSEY
W. 120 Century Rd.
Paramus, NJ 07652

AUSTRALIA

Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130

CANADA

Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
Mississauga, Ontario
Canada L4V 1M8

ITALY

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio, 9
20063 Cernusco
Sul Naviglio (MI)

FRANCE

Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
F-91401 Orsay Cedex

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernerstrasse 117
Postfach 560 140
D-6000 Frankfurt 56

NETHERLANDS

Hewlett-Packard Benelux N.V.
Van Heuven Doedhartlaan 121
P.O. Box 667
NL-Amstelveen 1134

UNITED KINGDOM

Hewlett-Packard Ltd.
King Street Lane
GB-Winnersh, Wokingham
Berks, RG11 5AR

AFRICA, ASIA, CENTRAL AND SOUTH AMERICA

Hewlett-Packard Intercontinental
3200 Hillview Avenue
Palo Alto, CA 94304

HEWLETT
PACKARD

HP Part No. 00346-90010

Printed in U.S.A.